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these quantities are designated by r and p respectively. Probably the chance of interesting investigators in the use of the method of least squares would be increased if confusion due to non-uniformity of notation could be avoided.

Every intelligent observer desires some concrete expression of the quality of his observations; the computer who has to combine the results of different series of observations should have some knowledge of their relative accuracy in order to assign to each series its proper weight; and the investigator engaged in a complicated series of experiments desires some criterion by which to estimate the relative errors of the several parts of his work and to apportion properly his care among them. Experienced judgment will go a great way, but the working method of least squares, which has been developed on the basis of experience and analysis into its present form by a succession of thinkers, presents clearly the safest means of obtaining the result of highest probability from a given set of observations and provides methods for appraising the accuracy of such a result and for expressing this accuracy vividly to others. The present volume is planned with the purpose of making the elements of the theory of errors and least squares easily attainable both by students and by research workers. It will prove useful in the class room, in reference libraries and also on the desk.

R. H. CURTISS.

Plane Trigonometry, with Tables. By A. M. HARDING and J. S. TURNER. G. P. Putnam's Sons, New York, 1915. 158 + 51 pages. $1.10 net.

It would be decidedly interesting to know how many trigonometries have been written since Nasir Eddin (or whoever it was) delivered the subject from its bondage to astronomy. It would be much more interesting to know how many authors have, more or less unconsciously, recast the material in the mould of an older form.

At present, in the writing of American trigonometries, we seem to be passing through a period which may, with some appropriateness, be called a "reversion to type." The trigonometry under review, like the Kenyon and Ingold (published 1913) and the Wilczynski and Slaught (published 1914), makes the discussion and solution of triangles the first consideration and admits no diversion until this problem has been completely solved. In the preface we find:

"During the last few years great modifications have been made in the method of presenting plane trigonometry. Formerly the student was introduced to the trigonometric functions without any explanation of their practical utility, and spent three-fourths of his time groping in the dark with trigonometric formulas and identities. The result was that the average student found the subject repulsive.

"In accordance with the modern tendency we have introduced the ratios a few at a time, and then proceeded as soon as possible to the solution of triangles, leaving the more difficult theoretical parts of the subject until the last."

And yet the Davies' *Legendre*, almost universally used in this country for a considerable period more than fifty years ago, made the solution of triangles the first consideration and, after having completely disposed of that, took up the general properties and relations of the trigonometric functions (functions of any angle, fundamental relations, addition and factoring formulas, etc.) under the title "Analytical Trigonometry." The same order is to be found in Loomis's *Trigonometry* (copyright 1858) of which more than 60,000 copies were printed before the first revised edition was issued.

The comprehensive and well-written textbook of Chauvenet (copyright 1850) placed the treatment of the general properties and relations of the trigonometric functions before any solutions of triangles. This arrangement was adopted by the popular textbooks of Olney (copyright 1870), Wheeler (copyright 1876), Oliver, Wait and Jones (copyright 1881) and Wells (copyright 1883).

Wentworth's trigonometry appeared in 1882 with an order of treatment that seemed to be a kind of compromise between that of Davies' *Legendre* and Chauvenet. The solution of right triangles was placed near the beginning; between that and the solution of oblique triangles was inserted, under the caption "Goniometry," a discussion of the general properties and relations of the trigonometric functions whose content was slightly greater than the "Analytic Trigonometry" which followed the solution of triangles in the Davies' *Legendre* text, and nearly equivalent to three of the chapters (II, III and IV) which preceded the solution of any triangles in the Chauvenet. Simon Newcomb's trigonometry appeared about the same time with a somewhat similar arrangement, but with more of the analytic material preceding the chapter on right triangles.

Wentworth's trigonometry may not have been the first of its type but its great success undoubtedly accounts for the fact that one can readily name ten or fifteen trigonometries published since 1890 which have adopted this hybrid order of placing the "analytical trigonometry" or "trigonometric analysis" between the discussion of right triangles and the discussion of oblique triangles. The tendency at present, of which the book under review is representative, seems to be to put the treatment of oblique triangles back to its original position.

The introductory chapter of the book under review is distinctive. At least, the reviewer knows of no other trigonometry beginning with a similar chapter intended to serve as a connecting link between plane geometry and plane trigonometry. This chapter consists of 13 pages devoted to the measurement of lines, areas and angles (in the sexagesimal system only), the proofs of five theorems on similar triangles, and 19 exercises. At least a part of this material would not be new to a college freshman, but the authors seem to take no cognizance of this fact. The reviewer wonders if students reading the chapter might not be puzzled to understand why proofs are given of some of the theorems they have already proved in elementary geometry and why, at the same time, the validity of other theorems is assumed in making these proofs.

A distinctive feature of Chapter II is that the trigonometric functions are introduced two at a time. After defining the sine and cosine of an angle, several exercises are introduced to fix these concepts before introducing the tangent and cotangent. Similar sets of exercises are given after each of the other two pairs. The second chapter also includes eight of the fundamental relations of the functions, the functions of the special angles 30°, 45°, 60°, and of complementary angles, and an explanation of the use of a table of natural functions. The explanation of the table is well written and the reviewer believes its introduction at this place is a better plan than to put it back with the tables.

Chapter III treats of right-angled triangles and the experience of many teachers attests that the authors are wise in making no use of logarithms throughout the chapter.

The next five chapters (IV to VIII inclusive) treat of logarithms, oblique triangles, trigonometric functions of any angle, trigonometric functions of two or more angles, circular measure, inverse functions and trigonometric equations, in the order named. While there are some slight changes in these chapters which may be considered improvements, the reviewer has not discovered anything startlingly different from other customary treatments.

The closing chapter (IX) treats of some applications of trigonometry to geometry. This chapter again suggests the older (as well as various English) trigonometries, since the indebtedness to Chauvenet and Loney, acknowledged in the preface, is here most in evidence. Such a chapter, exhibiting the value and power of trigonometry in dealing with old forms, will probably contribute to increased interest on the part of the student. About 600 exercises are included and the answers to part of them are collected after Chapter IX.

The mechanical make-up of the book leaves much to be desired. The figures (cf. Figs. 45, 53) and pages of formulas (cf. pp. 98–100) suffer somewhat in comparison with others which readily come to mind. The use of disproportionately small exponents (cf. pp. 112–113), roman θ and italic ϕ in the same formula (cf. pp. 108, 122) and of a clumsy sign for $\mp$ (cf. pp. 69, 114) suggests lack of the best equipment for mathematical printing.

While one may not agree entirely with the selection or order of subject-matter, one feels immediately that this book was written by men who know something of the processes through which a freshman's mind passes in studying trigonometry. One feels confidence that the book is usable—that it "will teach," as it is sometimes expressed.

A notable omission, the absence of any use of coördinates, also intimates a turning toward older methods. But, after all, the biologists assure us that "reversion to type" is a true test of species.

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